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(54) **Controlled environment transportation of respiring comestibles.**

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Description

The present invention relates to improvements in and/or relating to the carriage of comestibles and/or plants whether cut or not (hereinafter simply "comestibles") and in particular to an apparatus applicable thereto including containers and related means and methods.

In New Zealand Patent Specification No. 205453 (US patent 4642996, Australian patent 567966 and other equivalents thereto) there is disclosed a system utilising shipping containers whereby the respiring comestible is loaded into a container, the container is then sealed sufficiently to ensure that less oxygen from ambient air can diffuse into the container than is required for respiration by the comestible, flushing the container (preferably with a nitrogen rich gas) to reduce the oxygen level in the container atmosphere below that of the ambient air and transporting the container while monitoring at least the carbon dioxide and oxygen levels (and preferably also the temperature) within the container and adjusting as necessary, (a) the oxygen content by positive infusion of ambient air into the container in response to such monitoring towards an optimum or predetermined value or range of values, (b) the carbon dioxide content by absorbing carbon dioxide from the atmosphere in the container in response to such monitoring towards an optimum or predetermined value or range of values and (c) the temperature, if monitored, by refrigeration in response to such monitoring towards an optimum or predetermined value or range of values.

The present invention recognises that the system disclosed in the aforementioned patent specification can further be improved, in particular in relation to control of the carbon dioxide presence in the container.

It is also recognised that while a system in accordance with the present invention is most appropriate for use with shipping "containers" where there is a wish to obviate the need for the transportation of pressurised or liquefied gases therewith, such a system is equally appropriate in other carriage spaces, eg. the cargo hold of an aircraft, ship, train or the like and therefore for the purposes of the present specification the word "container" as used herein relates not only to shipping containers but to any means defining a storage space for such comestibles.

In a system such as disclosed in the aforementioned patent specification the quantity of carbon dioxide capable of being absorbed is finite where reliance is placed upon a finite amount of a carbon dioxide absorbing medium such as, for example, a scrubbing unit including hydrated lime. Moreover there is also the prospect of carbon dioxide build up where for some reason or another a flow of the gaseous environment of the container can not be ducted through any such carbon dioxide scrubbing device.

It is therefore an object of the present invention to provide a method and related apparatus which will provide some safeguard in the event the carbon dioxide content of the container rises above a desirable level.

Accordingly the present invention, in one aspect, provides a method of transporting a quantity of a comestible which may be subject to degradation as a result of respiration during transportation, comprising the steps of:

(a) sealing or substantially sealing said quantity of the respiring comestible within a container, wherein "container" is defined as any means defining storage space for respiring comestibles, sufficiently to ensure that less oxygen of the ambient air can diffuse into the container than is required for full respiration by the respiring comestible, flushing the container with an oxygen low or oxygen free gas so as to provide a reduced oxygen level in the sealed or substantially sealed container, such flushing occurring before, during and/or after said sealing or substantial sealing, and

(b) transporting the container with the respiring comestible therein while (i) monitoring the oxygen level within said container and automatically adjusting the oxygen level as necessary by a positive infusion of ambient air into the container in response to such monitoring towards an optimum or predetermined value or range of values and (ii) monitoring the carbon dioxide level within said container and adjusting the carbon dioxide level as necessary in response to such monitoring towards and optimum or predetermined value or range of values without reliance upon flushing with an oxygen low or oxygen free gas, said adjustment being firstly by means of a scrubbing of the air within said container should said carbon dioxide level rise above a first predetermined value, and, secondly, should said carbon dioxide level rise above a second higher predetermined value, by the positive infusion of ambient air into the container.

Preferably said container is refrigerated and there is automatic adjustment of the temperature.

A further aspect of the present invention consists in an apparatus for transporting a quantity of respiring comestibles which may be degraded by respiration, said apparatus comprising:

transportable means defining a volume of a gaseous environment for said comestibles capable of being substantially sealed and in which the comestibles to be transported can be carried;

means to seal or substantially seal said volume after loading with said comestibles such that less

oxygen from the ambient air can diffuse into the environment than is required for the respiration;

means to enable flushing of the environment with an oxygen free or low gas to reduce the oxygen content thereof below that of ambient air;

means to monitor the oxygen content of the environment;

means to monitor the carbon dioxide content of the environment;

means responsive to the means to monitor said oxygen content to cause a positive infusion of ambient air into the environment should the oxygen content be or fall below a predetermined value;

means responsive to the means to monitor said carbon dioxide content to cause passage of gas within the environment through means to scrub at least some of the carbon dioxide therefrom should carbon dioxide content rise above a first predetermined value; and

means responsive to the means to monitor said carbon dioxide content to cause a positive infusion of ambient air into the environment should said carbon dioxide content not be maintained below a higher second predetermined value by said means to scrub at least some carbon dioxide from the environment.

Preferably said apparatus includes means to monitor the temperature of the environment and additionally means responsive to the means to monitor the temperature of the environment to adjust at least downwardly the temperature of the environment towards a predetermined value.

The environment may be within a container which defines a storage space for respiring comestibles.

A third aspect of the invention provides a gas controller for a container, wherein "container" is defined as any means defining a storage space for respiring comestibles, having means for extraction of CO_2 from the container air and means for exchange of ambient air with container air, said controller comprising:

a microprocessor, read-only memory and read-write memory connected to a common communication bus;

a carbon dioxide detector for monitoring the level of carbon dioxide in the container air;

an oxygen detector for monitoring the level of oxygen in the container air;

means for connecting the output of said detectors to said bus; and

an output port connected to said bus for output from said microprocessor of control signals which activate/deactivate said means for extraction and means for exchange;

wherein said microprocessor executes a program stored in said read-only memory which program:

(a) monitors said carbon dioxide and oxygen level;

(b) activates/deactivates said means for extraction if said carbon dioxide level rises above/falls below a predetermined carbon dioxide high limit or range of limits;

(c) activates/deactivates said means for exchange if said carbon dioxide level rises above/falls below a predetermined carbon dioxide high limit or range of limits; and

(d) activates/deactivates said means for exchange if said oxygen level falls below/rises above a predetermined oxygen level or range of levels.

One preferred form of the present invention will now be described with reference to the accompanying drawings in which:

Figure 1 is a block diagram of a controller which may be used to implement the present invention; and

Figures 2 and 3 are flow diagrams for portions of the controller microprocessor program.

The controller, hereinafter described, is now preferred to be used in connection with the container systems described in the aforementioned specifications, particularly with reference to Figures 1-7 of those specifications, as a replacement for the controller described in relation to Figures 8-10 of those specifications. Such figures and the description thereof is hereby herein incorporated by way of reference.

The controller is a microprocessor based unit which measures, controls, displays and logs levels of carbon dioxide and oxygen in a container as hereinbefore defined, particularly a refrigerated marine shipping container. Control of the gas levels may be achieved via solenoid valves built into the container and connected to the controller. In the case of CO_2, valves are provided to (i) allow passage of container air through a scrubber unit in order to prevent the CO_2 level of the container air rising above a predetermined level, and (ii) allow an infusion of ambient air to the container should the CO_2 level rise above a higher predetermined level, such as in the event of failure of the scrubber action. In the case of O_2, the external valves of (ii) allow an infusion of ambient air to the container in order to prevent the O_2 level of the container air from falling below a predetermined level. The controller is intended to be portable and of a size and shape to fit in the electrical power control box of such containers.

Referring to Figure 1, the controller schematically comprises a microprocessor 1 which operates according to a program stored in read-only memory 2. The microprocessor reads and writes to and from read/write memory 3 and a removable cassette in cassette unit 4. A gas pump 5 continuously draws air from the container through inlet 15 and consecutively through 0_2 detector 6 and CO_2 detector 7. Outlet 16 may return the sampled air to the container or its surroundings. A temperature detector 8 monitors

approximately the temperature of the controller itself. Analog multiplexer 9 passes any of the three detector output signals to analog-to-digital converter 10 in response to commands by the microprocessor. The selected detector signal is then passed to the microprocessor on a common data/address bus 11.

Microprocessor 1 calculates actual CO_2 and O_2 levels by applying corrections to the detected levels as necessary depending on the detectors used. The CO_2 and O_2 levels according to the most recent sample are then shown on display 12, and may at suitable intervals be stored on the cassette, in addition to the detected temperature and the time according to real time clock 13. The microprocessor compares the actual CO_2 and O_2 levels with predetermined setpoints, these being preferred levels which vary with particular comestibles. Action of the container valves is controlled by the microprocessor.

It has been practical to group comestibles commonly transported by container into two categories, having preferred CO_2 levels greater or less than 3% by volume of the container air. A high CO_2 limit is defined for each category, above which unacceptable damage to the comestibles occurs. When the preferred level is less than 3% the high limit is 5%, and when the preferred level is greater than 3% the high limit is 5% plus the preferred level.

That part of the microprocessor program which enacts the present invention will now be described with reference to the flow charts of figures 2 and 3.

In Figure 2, action may be taken in respect of the container CO_2 and O_2 levels, provided that the container is not undergoing defrosting. The microprocessor then proceeds to compare the CO_2 level with the CO_2 setpoint and then with the CO_2 high limit value. If the CO_2 high limit is exceeded, ambient air is drawn into the container to lower the container air CO_2 level, otherwise the O_2 level is compared with the O_2 setpoint. CO_2 high limit control thus overrides O_2 level control. In making each comparison and operating valves if necessary, program execution passes to the routine shown in Figure 3.

Referring to Figure 3, the microprocessor calculates an error equal to the deviation of the CO_2 or O_2 level from the corresponding setpoint, and calculates a control value equal to the error magnitude less the deadband amplitude. If the control value is negative the error is within the deadband and the existing valve status is maintained. If the control value is positive, the error is outside the deadband and action may be taken as follows. If the CO_2 level and setpoint are being compared, a positive error indicates that the level is undesirably high and the scrubber valve should be opened or remain open, while a negative error indicates that the level is below the setpoint and the scrubber valve should be closed or remain closed. If the O_2 level and setpoint are being compared, a positive error indicates that the level is above the setpoint and the external valve should be closed, while a negative error indicates that the level is undesirably low and the external valves should be opened or remain open.

Principal features of a specific embodiment of the invention will now be described. In this embodiment the microprocessor 1 is an Intel 8085 8-bit processor. The other components of the controller shown in figure 1 interface with the data/address bus via an 8255 programmable peripheral interface, except that the external ports 15 include an 8251 programmable communications interface for connection of the controller to a further microprocessor if desired. The ROM 2 in which the microprocessor program is stored comprises two 32K 2732 EPROMS while the RAM 3 comprises a 2K 6116 static RAM. The analog multiplexer 9 and analog-to-digital converter 10 comprise 4051 and ADC0802 chips respectively. The setpoints for a particular container load are stored in the cassette after input from a portable computer via the 8251 interface as noted above, an the controller cannot exercise the routine of figure 2 unless the cassette is in place. Deadband values (0_2:±0.3%, CO_2:±0.5%) are stored in the EPROMS and are not varied between loads.

A "Teledyne"* type A5 microfuel cell detects oxygen in the container air up to 25% by volume and with 10% accuracy of reading. The cell output is temperature dependent for which compensation is achieved via a thermistor in the cell output circuit.

A four filament "Gowmac"* thermal conductivity cell is used to detect the presence of carbon dioxide in the container air up to 25% by volume. Each filament of the detector comprises one arm of a resistance bridge, two filaments being used for gas measurement and two filaments for reference. Such a detector is not intrinsically CO_2 sensitive but also reflects the O_2 and NO_2 levels of the container air. The microprocessor therefore compensates the conductivity cell output according to the detected O_2 level and an estimate of the N_2 level. The CO_2 detector is also temperature dependent for which further compensation is made by the microprocessor via the output of temperature detector 8. Overall, the CO_2 level obtained with 1%

* Teledyne Analytical Instruments Box 1580 City of Industry CA 91749 USA

* Gowmac USA Box 32 NJ 08805 USA

accuracy.

A "Wisa" * vibrator type pump draws container air through the detectors at 0.2-0.5 l/minute. The air is filtered before passage through the CO_2 detector.

Each detector output is read by the microprocessor approximately once every second and a running average for each level is calculated to overcome noise, the detector outputs being compensated as noted previously. The latest averages are displayed on the front panel of the controller and compared with the setpoints. The container CO_2 and O_2 levels and controller temperature are recorded on the cassette approximately every 8 hours when the container and controller are in use. There is provision to monitor and record the temperature within the container through a further communications port in the container, not shown in figure 1, if desired.

Appendix I is a portion of an 8085 assembly language program listing in which lines 222-335 correspond approximately to the flow chart of Figure 2.

Appendix II is a portion of an 8085 assembly language program listing in which lines 1134-1168 carry out CO_2 level compensation for the CO_2 detector temperature, lines 117-1200 carry out CO_2 level compensation in accord with the O_2 level, and lines 1219-1272 correspond approximately to the flow chart of Figure 3.

It is believed that apparatus and methods in accordance with the present invention define widespread application in the transportation industry.

* Wisa Precision Pumps Bayonne NJ 07002 USA

APPENDIX 1

```
ISIS-II 8080/8085 MACRO ASSEMBLER, V4.1          TFCVF
RANGFRESH 300 SERIES CONTROLLER

 LOC  OBJ           LINE        SOURCE STATEMENT

00C0 CD0506   C     214          CALL    LOG
00C3 AF             215          XRA     A
00C4 32E400   D     216          STA     LOGF    ;AND RESET LOG FLAG
                    217
                    218 ; COMPENSATE AND SCALE INPUTS
00C7 CDA006   C     219 MAIN1:   CALL    TFCMP
                    220
                    221 ; CONTROL OUTPUTS
00CA 3A0430         222          LDA     PORTA
00CD 47             223          MOV     B,A
00CE E620           224          ANI     DFRST   ;DEFROSTING?
00D0 CAA301   C     225          JZ      DPPTR   ;YES, EXIT
                    226
00D3 78             227          MOV     A,B
00D4 E680           228          ANI     CART    ;CARTRIDGE INSERTED
00D6 C2A301   C     229          JNZ     DPPTR   ;NO, EXIT
                    230
                    231 ; DO CONTROL ACTION ON CO2
00D9 110A40         232          LXI     D,ESPCO2 ;GET CO2 SET POINT
00DC CD1E08   C     233          CALL    SPCV    ;CONVERT
                    234
00DF 012300   D     235          LXI     B,TCO2  ;CO2 VALUE
00E2 113300   D     236          LXI     D,TMP   ;SET POINT
00E5 214300   C     237          LXI     H,DBCO2 ;DEADBAND
00E8 3E00           238          MVI     A,0     ;NEGATIVE CONTROL ACTION
00EA CDDB07   C     239          CALL    CTLA
                    240
00ED DA0201   C     241          JC      CON3
00F0 79             242          MOV     A,C
00F1 B7             243          ORA     A
00F2 3A0530         244          LDA     PORTB
00F5 CAFC00   C     245          JZ      CON1
00F8 E6FB           246          ANI     NOT RYCO2
00FA C3FF00   C     247          JMP     CON2
00FD F604           248 CON1:    ORI     RYCO2
00FF 320530         249 CON2:    STA     PORTB
                    250
0102 213300   D     251 CON3:    LXI     H,TMP   ;CLEAR TEMP
0105 0604           252          MVI     B,4
0107 CD0000   E     253          CALL    CLRM
                    254
                    255 ;CHECK CO2 LIMIT
010A 110A40         256          LXI     D,ESPCO2 ;GET CO2 SET POINT
010D CD1E08   C     257          CALL    SPCV    ;CONVERT
                    258
                    259 ;        SET POINT < 3%
0110 012300   D     260          LXI     B,TMP   ;SET POINT
0113 11F000   C     261          LXI     D,FC3   ;- 3%
0116 213700   D     262          LXI     H,TMP+4
0119 CD0000   E     263          CALL    SUB32
011C 3A3A00   D     264          LDA     TMP+7   ;GET SIGN BIT
011F 0F             265          RRC             ;-VE
0120 DA3501   C     266          JC      CON4    ;YES, SET TO 3%
                    267
                    268 ;        > 3%  SET POINT = SET POINT + 3%
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:IS-II 8080/8085 MACRO ASSEMBLER, V4.1          TFCVF
:ANSFRESH 300 SERIES CONTROLLER

 LOC  OBJ          LINE        SOURCE STATEMENT

0125 013300    D    269          LXI     B,TMP    ;SET POINT =
0128 113500    C    270          LXI     D,PC5    ;SET POINT +
0129 213600    D    271          LXI     H,TMP+3  ;5%
012C CD0000    E    272          CALL    ADD32
012F 113600    D    273          LXI     D,TMP+3  ;-> SETPOINT + 5%
0132 C33501    C    274          JMP     CON5
                    275
                    276 ;        < 3%  SET POINT = 5%
0135 113300    C    277 CON4:    LXI     D,PC3    ;-> 3%
                    278
0138 012300    D    279 CON5:    LXI     B,TCO2   ;-> CO2 COMPENSATED
013B 214B00    C    280          LXI     H,PC1    ;-> DEADBAND
013E 3E00           281          MVI     A,0      ;CONTROL +VE
0140 CDDB07    C    282          CALL    CTLA
                    283
                    284 ;        DO CONTROL ACTION
0143 DA5B01    C    285          JC      CON6     ;ACTION REQUIRED, NO ->
0146 79             286          MOV     A,C      ;ON OR OFF
0147 B7             287          ORA     A
0148 3A0530         288          LDA     PORTB    ;GET PORT
014B CA5301    C    289          JZ      CONA     ;OFF ->
014E E6FD           290          ANI     NOT RYTB ;LIMIT OFF
0150 C35501    C    291          JMP     CONB
0153 F602           292 CONA:    ORI     RYTB     ;LIMIT ON
0155 320530         293 CONB:    STA     PORTB
                    294 .
0158 3A0530         295 CON6:    LDA     PORTB    ;CHECK LIMIT
015B E602           296          ANI     RYTB     ;LIMIT SET?
015D CA6801    C    297          JZ      CONC     ;NO, CONT
0160 3A0530         298          LDA     PORTB    ;GET PORT AGAIN
0163 F601           299          ORI     RYO2     ;YES, SET RYO2
0165 320530         300          STA     PORTB
0168 C3A801    C    301          JMP     DPPTR    ;NEXT FUNCTION
                    302
016B 213300    D    303 CONC:    LXI     H,TMP    ;CLEAR TEMP
016E 0603           304          MVI     B,3
0170 CD0000    E    305          CALL    CLRM
                    306
                    307 ;DO CONTROL ACTION ON OXYGEN
0173 110E40         308          LXI     D,ESP02 ;OXYGEN SET POINT
0176 CD1E08    C    309          CALL    SPCV     ;CONVERT
                    310
                    311 ;POINT TO APPROPIATE O2 CELL FOR CONTROL
0179 210500    D    312          LXI     H,AC2A   ;-> O2A
017C 3A6700    D    313          LDA     O2CF     ;FLAG SET?
017F B7             314          ORA     A
0180 CA8601    C    315          JZ      CON7     ;NO, CONT
                    316
0183 210F00    D    317          LXI     H,AO2B   ;YES POINT TO REF
                    318
0186 44             319 CON7:    MOV     B,H      ;H,L -> O2 VALUE TO USE
0187 4D             320          MOV     C,L      ;TRANSFER TO B,C
0188 113300    D    321          LXI     D,TMP    ;-> O2 SET-POINT
018B 214700    C    322          LXI     H,DBO2   ;-> O2 DEAD BAND
018E 3EFF           323          MVI     A,0FFH
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SIS-II 8080/8085 MACRO ASSEMBLER, V4.1          TPCVF
RANSFRESH 300 SERIES CONTROLLER

 LOC  OBJ          LINE      SOURCE STATEMENT

0170 CDD507   C     324         CALL    CTLA
                    325
0173 DAAE01   C     326         JC      DPPTR
0176 79             327         MOV     A,C
0177 B7             328         ORA     A
0178 3AC530         329         LDA     PORTB
017B CAAC01   C     330         JZ      CON3
017E E6FE           331         ANI     NOT RY02
01A0 C3A501   C     332         JMP     CON?
01A3 F601           333 CON3:   ORI     RY02
01A5 32C530         334 CON?:   STA     PORTB
                    335
                    336 ; SET DISPLAY POINTERS TO CO2 AND O2
01A8 112300   D     337 DPPTR:  LXI     D,TCO2  ;-> CO2 AVERAGE
01AB 210300   D     338         LXI     H,AO2A  ;-> O2A AVERAGE
01AE 3A6900   D     339         LDA     O2CF    ;O2 CONTROL FLAG
01B1 B7             340         ORA     A       ;SET?
01B2 CAB801   C     341         JZ      KPR     ;YES, LEAVE OA2
01B5 210F00   D     342         LXI     H,AO2B  ;NO, CHANGE TO O2B
                    343
                    344 ; ANY KEYS PRESSED
01B8 3A6500   D     345 KPR:    LDA     KEYF
01BB B7             346         ORA     A
01BC CA1F02   C     347         JZ      MAIN3   ;NO, CONT
                    348
                    349 ; NOW SEE WHICH KEY
01BF 3AC630         350         LDA     PORTC   ;GET KEY
01C2 E60F           351         ANI     0FH     ;STRIP UPPER
01C4 210300   D     352         LXI     H,AO2A  ;-> O2A
01C7 110F00   D     353         LXI     D,AO2B  ;-> O2B
01CA FE0D           354         CPI     SWP1    ;O2A & O2B REQUIRED?
01CC CA0902   C     355         JZ      KPR1    ;YES, JUMP OUT
01CF 211300   D     356         LXI     H,AT1   ;NO, -> TEMP 1
01D2 111700   D     357         LXI     D,AT2   ;-> TEMP 2
01D5 FE07           358         CPI     SWP3
01D7 CA0902   C     359         JZ      KPR1
01DA 212700   D     360         LXI     H,TT4   ;TEMPS 3 & 4
01DD 111B00   D     361         LXI     D,AT3
01E0 FE09           362         CPI     SWP4
01E2 CA0902   C     363         JZ      KPR1
01E5 B7             364         ORA     A       ;KEY RELEASED?
01E6 CA0902   C     365         JZ      KPR1    ;YES, EXIT
01E9 213300   D     366         LXI     H,TMP   ;CLEAR TEMP
01EC 0608           367         MVI     B,8
01EE CD0000   E     368         CALL    CLRM
01F1 110E40         369         LXI     D,ESPC2 ;O2 SET POINT
01F4 CD1E0E   C     370         CALL    SPCV    ;CONVERT
01F7 3A3400   D     371         LDA     TMP+1   ;GET VALUE
01FA 323B00   D     372         STA     TMP+5
01FD 110A40         373         LXI     D,ESPCO2 ;O2 SET POINT
0200 CD1E0E   C     374         CALL    SPCV
0203 213700   D     375         LXI     H,TMP+4
0206 113300   D     376         LXI     D,TMP
                    377
                    378 ; KEY PRESSED
```

APPENDIX 2

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IS-II 8080/8085 MACRO ASSEMBLER, V4.1          TFCVF
ANSFRESH 300 SERIES CONTROLLER

LOC  OBJ           LINE        SOURCE STATEMENT

06FF 35            1120          DCR     M
0700 C20106   C    1121          JNZ     AVRG
                   1122
0703 3EFF          1123          MVI     A,0FFH  ;SET FIRST TIME FLAG
0705 326A00   D    1124          STA     FIRSTF
                   1125
                   1126 ;NOW COMPENSATE THE AVERAGE VALUES
                   1127 ;EXPAND TEMPERATURE SCALE
0708 011F00   D    1128 TFC2:    LXI     B,AT4   ;AVERAGE TEMP
070B 11B507   C    1129          LXI     D,THR   ; X 3 =
070E 212700   D    1130          LXI     H,TT4   ;TRUE TEMPERATURE
0711 CD0000   E    1131          CALL    MUL32
                   1132
                   1133 ;COMPENSATE CO2 FOR TEMPERATURE
0714 012700   D    1134          LXI     B,TT4   ;DELTA T
0717 11CB07   C    1135          LXI     D,K4
071A 213D00   D    1136          LXI     H,TMP1
071D CD0000   E    1137          CALL    SUB32
                   1138
0720 013D00   D    1139          LXI     B,TMP1  ;DELTA T X 200
0723 11CF07   C    1140          LXI     D,K5
0726 213300   D    1141          LXI     H,TMP
0729 CD0000   E    1142          CALL    MUL32
                   1143
072C 010700   D    1144          LXI     B,AC02  ;CO2A X 1000
072F 11D307   C    1145          LXI     D,K6
0732 212300   D    1146          LXI     H,TC02
0735 CD0000   E    1147          CALL    MUL32
                   1148
0738 012300   D    1149          LXI     B,TC02  ;(CO2A X 1000)
073B 113300   D    1150          LXI     D,TMP   ;- ((TT4 - 640000) X 200)
073E 212300   D    1151          LXI     H,TC02
0741 CD0000   E    1152          CALL    SUB32
                   1153
0744 013D00   D    1154          LXI     B,TMP1  ;(TT4 - 640000)/569
0747 11D707   C    1155          LXI     D,K7
074A 213D00   D    1156          LXI     H,TMP1
074D CD0000   E    1157          CALL    DIV32
                   1158
0750 01D307   C    1159          LXI     B,K6    ;1000 - (DELTA T - 640000)
0753 113D00   D    1160          LXI     D,TMP1  ;                ----------------
0756 213D00   D    1161          LXI     H,TMP1  ;                     569
0759 CD0000   E    1162          CALL    SUB32
                   1163
075C 012300   D    1164          LXI     B,TC02  ;A - 0.2(DELTA T)
075F 113D00   D    1165          LXI     D,TMP1  ;----------------
0762 212300   D    1166          LXI     H,TC02  ; 1 - 0.0043(DELTA T)
0765 CD0000   E    1167          CALL    DIV32
                   1168
                   1169 ;COMPENSATE CO2 FOR O2 CONCENTRATION
0768 010B00   D    1170          LXI     B,AO2A  ;-> O2A
076B 3A6900   D    1171          LDA     O2CF    ;GET APPROPIATE
076E B7            1172          ORA     A       ;O2 READING
076F CA7507   C    1173          JZ      AVG1
0772 010F00   D    1174          LXI     B,AO2P
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8IS-II 8080/8085 MACRO ASSEMBLER, V4.1          TFCVF
RANSFRESH 300 SERIES CONTROLLER

 LOC  OBJ           LINE        SOURCE STATEMENT
                    1175
                    1176 ;COMPENSATE CO2 DATA
 0775 115807    C   1177 AVG1:   LXI     D,TEN    ;CO2 / 10
 0778 213D00    D   1178         LXI     H,TMP1
 077B CD0000    E   1179         CALL    DIV32
                    1180
 077E 012300    B   1181         LXI     B,TCO2   ;CO2 + 02/10
 0781 113D00    D   1182         LXI     D,TMP1
 0784 213D00    D   1183         LXI     H,TMP1
 0787 CD0000    E   1184         CALL    ADD32
                    1185
 078A 013D00    D   1186         LXI     B,TMP1   ;(CO2 + 02/10) - 2(UNITS)
 078D 11AF07    C   1187         LXI     D,TWOU
 0790 213D00    D   1188         LXI     H,TMP1
 0793 CD0000    E   1189         CALL    SUB32
                    1190
 0796 013D00    D   1191         LXI     B,TMP1   ;(CO2 - 2 + 02/10)
 0799 118707    C   1192         LXI     D,NINE   ;-----------------
 079C 213D00    D   1193         LXI     H,TMP1   ;       9
 079F CD0000    E   1194         CALL    DIV32
                    1195
 07A2 013D00    D   1196         LXI     B,TMP1   ;(CO2 - 2 + 02/10) X 10/9
 07A5 11BB07    C   1197         LXI     D,TEN
 07A8 212300    D   1198         LXI     H,TCO2
 07AB CD0000    E   1199         CALL    MUL32
                    1200
 07AE C9            1201         RET
                    1202
 07AF 7C14          1203 TWOU:   DW      5244,0   ;TWO (UNITS)
 07B1 0000
 07B3 0300          1204 THR:    DW      3,0      ;THREE
 07B5 0000
 07B7 0900          1205 NINE:   DW      9,0      ;NINE
 07B9 0000
 07BB 0A00          1206 TEN:    DW      10,0     ;TEN
 07BD 0000
 07BF ED17          1207 K1:     DW      6125,0   ;CONSTANT 1
 07C1 0000
 07C3 3958          1208 K2:     DW      22585,0  ;CONSTANT 2
 07C5 0000
 07C7 1000          1209 K3:     DW      16,0     ;CONSTANT 3
 07C9 0000
 07CB 00FA          1210 K4:     DW      64000,0  ;CONSTANT 4
 07CD 0000
 07CF 1400          1211 K5:     DW      20,0     ;CONSTANT 5
 07D1 0000
 07D3 E803          1212 K6:     DW      1000,0   ;CONSTANT 6
 07D5 0000
 07D7 3902          1213 K7:     DW      569,0    ;CONSTANT 7
 07D9 0000
                    1214
                    1215 ;**********************************************************
                    1216
                    1217 ;CLTA:-          CONTROL ACTION SUBROUTINE
                    1218
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ISIS-II 8080/8085 MACRO ASSEMBLER, V4.1          TFCVF
TANGFRESH 300 SERIES CONTROLLER

 LOC  OBJ           LINE        SOURCE STATEMENT

                    1219 ;ENTER: BC -> INPUT VARIABLE
                    1220 ;       DE -> SET-POINT VALUE
                    1221 ;       HL -> DEADBAND VALUE
                    1222 ;       A = CONTROL ACTION, 00=+VE, FF=-VE
                    1223
                    1224 ;EXIT:  CARRY, NO ACTION ERROR<DEADBAND
                    1225 ;       C = ACTION 00(OFF), FF(ON).
                    1226
                    1227 ;-------------------------------------------------
                    1228
07DB F5             1229 CTLA:   PUSH    PSW      ;SAVE ACTION
07DC E5             1230         PUSH    H        ;SAVE DEADBAND POINTER
                    1231
                    1232         ;ENTERS WITH BC, DE SET
07DD 213300     D   1233         LXI     H,TMP    ;ERROR
07E0 CD0000     E   1234         CALL    SUB32
                    1235
07E3 AF             1236         XRA     A        ;RESET
07E4 326800     D   1237         STA     NEGF     ;NEGATIVE FLAG
                    1238
07E7 213A00     D   1239         LXI     H,TMP+3
07EA 7E             1240         MOV     A,M      ;ERROR -VE?
07EB 07             1241         RLC
07EC D2FA07     C   1242         JNC     $+15     ;NO, ->
07EF 3EFF           1243         MVI     A,0FFH   ;YES,
07F1 326800     D   1244         STA     NEGF     ;NEGATIVE FLAG
07F4 213300     D   1245         LXI     H,TMP
07F7 CD0000     E   1246         CALL    COMPHL   ;MAKE POSITIVE
                    1247
07FA 013300     D   1248         LXI     B,TMP    ;ERROR
07FD D1             1249         POP     D        ;DEADBAND
07FE 213300     D   1250         LXI     H,TMP    ;CONTROL REQUIRED
0801 CD0000     E   1251         CALL    SUB32
                    1252
0804 3A3600     D   1253         LDA     TMP+3    ;ERROR < DEADBAND?
0807 07             1254         RLC
0808 C1             1255         POP     B        ;GET ACTION
0809 D8             1256         RC               ;ERROR < DEADBAND, RETURN
080A 78             1257         MOV     A,B
080B B7             1258         ORA     A
080C CA1108     C   1259         JZ      $+5      ;ACTION +,RETURN WITH 00H
080F 3EFF           1260         MVI     A,0FFH   ;ACTION -,RETURN WITH 0FFH
0811 4F             1261         MOV     C,A      ;PUT ACTION IN C
                    1262
0812 3A6800     D   1263         LDA     NEGF     ;WAS ERROR -VE?
0815 B7             1264         ORA     A
0816 CA1C08     C   1265         JZ      $+6      ;NO, ->
0819 79             1266         MOV     A,C      ;YES, COMPLEMENT
081A 2F             1267         CMA
081B 4F             1268         MOV     C,A
                    1269
081C AF             1270         XRA     A        ;CLEAR ACTION FLAG
081D C9             1271         RET
                    1272
                    1273 ;-------------------------------------------------
```

Claims

1. A method of transporting a quantity of a comestible which may be subject to degradation as a result of respiration during transportation, comprising the steps of:

   (a) sealing or substantially sealing said quantity of the respiring comestible within a container, wherein 'container' is defined as any means defining storage space for respiring comestibles, sufficiently to ensure that less oxygen of the ambient air can diffuse into the container than is

required for full respiration by the respiring comestible, flushing the container with an oxygen low or oxygen free gas so as to provide a reduced oxygen level in the sealed or substantially sealed container, such flushing occurring before, during and/or after said sealing or substantial sealing, and (b) transporting the container with the respiring comestible therein while (i) monitoring the oxygen level within said container and automatically adjusting the oxygen level as necessary by a positive infusion of ambient air into the container in response to such monitoring towards an optimum or predetermined value or range of values and (ii) monitoring the carbon dioxide level within said container and adjusting the carbon dioxide level as necessary in response to such monitoring towards and optimum or predetermined value or range of values without reliance upon flushing with an oxygen low or oxygen free gas, said adjustment being firstly by means of a scrubbing of the air within said container should said carbon dioxide level rise above a first predetermined value, and, secondly, should said carbon dioxide level rise above a second higher predetermined value, by the positive infusion of ambient air into the container.

2. A method as claimed in claim 1 wherein said container is refrigerated and there is automatic adjustment of the temperature.

3. Apparatus for transporting a quantity of respiring comestibles which may be degraded by respiration, said apparatus comprising:

transportable means defining a volume of a gaseous environment for said comestibles capable of being substantially sealed and in which the comestibles to be transported can be carried;

means to seal or substantially seal said volume after loading with said comestibles such that less oxygen from the ambient air can diffuse into the environment then is required for the respiration;

means to enable flushing of the environment with an oxygen free or low gas to reduce the oxygen content thereof below that of ambient air;

means to monitor the oxygen content of the environment;

means to monitor the carbon dioxide content of the environment;

means responsive to the means to monitor said oxygen content to cause a positive infusion of ambient air into the environment should the oxygen content be or fall below a predetermined value;

means responsive to the means to monitor said carbon dioxide content to cause passage of gas within the environment through means to scrub at least some of the carbon dioxide therefrom should said carbon dioxide content rise above a first predetermined value; and

means responsive to the means to monitor said carbon dioxide content to cause a positive infusion of ambient air into the environment should said carbon dioxide content not be maintained below a higher second predetermined value by said means to scrub at least some carbon dioxide from the environment.

4. Apparatus as claimed in claim 3 wherein said environment is within a container which defines a storage space for respiring comestibles.

5. Apparatus as claimed in claim 3 wherein there is provided means to monitor the temperature of the environment and additionally means responsive to the means to monitor the temperature of the environment to adjust at least downwardly the temperature of the environment towards a predetermined value.

6. A gas controller for a container, wherein "container" is defined as any means defining a storage space for respiring comestibles, having means for extraction of CO_2 from the container air and means for exchange of ambient air with container air, said controller comprising:

a microprocessor, read-only memory and read-write memory connected to a common communication bus;

a carbon dioxide detector for monitoring the level of carbon dioxide in the container air;

an oxygen detector for monitoring the level of oxygen in the container air;

means for connecting the output of said detectors to said bus; and

an output port connected to said bus for output from said microprocessor of control signals which activate/deactivate said means for extraction and means for exchange;

wherein said microprocessor executes a program stored in said read-only memory which program:

(a) monitors said carbon dioxide and oxygen level;

(b) activates/deactivates said means for extraction if said carbon dioxide level rises above/falls below a predetermined carbon dioxide level or range of levels;
(c) activates/deactivates said means for exchange if said carbon dioxide level rises above/falls below a predetermined carbon dioxide high limit or range of limits exceeding said carbon dioxide level or range of levels; and
(d) activates/deactivates said means for exchange if said oxygen level falls below/rises above a predetermined oxygen level or range of levels.

7. A gas controller according to claim 6 wherein said activation/deviation comprises opening/closing of solenoid valves.

8. A gas controller according to claim 6 or claim 7 wherein said predetermined levels are preferred levels for transport of respiring comestibles within said container.

9. A gas controller according to any one of claims 6 to 8 wherein said predetermined carbon dioxide limit is a limit above which unacceptable damage occurs to comestibles being transported in said container.

10. A gas controller according to any one of claims 6 to 9 wherein said means for connecting the output of said detectors to said bus comprises an analog multiplexer in series with an analog-to-digital converter.

11. A gas controller according to any one of claims 6 to 10 wherein said program records at predetermined intervals said carbon dioxide an oxygen levels in a removable memory element connected to said microprocessor via said bus.

Patentansprüche

1. Verfahren zum Transport einer Menge eines Lebensmittels, das sich während des Transports infolge Atmung zersetzen kann, umfassend die folgenden Schritte:
(a) die Menge des atmenden Lebensmittels in einem Behälter dicht oder im wesentlichen dicht verschließen, wobei "Behälter" definiert ist als jede Einrichtung, die einen Lagerraum für atmende Lebensmittel aufweist, der mit hinreichender Sicherheit gewährleistet, daß weniger Sauerstoff aus der Umgebungsluft in den Behälter eindringen kann als von dem atmenden Lebensmittel zur vollständigen Atmung benötigt wird, Spülen des Behälters mit einem sauerstoffarmen oder sauerstofffreien Gas, so daß in dem dicht oder im wesentlichen dicht verschlossenen Behälter ein verminderter Sauerstoffgehalt erreicht wird, wobei das Spülen vor, während und/oder nach dem dichten oder im wesentlichen dichten Verschließen erfolgt, und
(b) Transportieren des Behälters mit dem darin enthaltenen atmenden Lebensmittel, während (i) der Sauerstoffgehalt in dem Behälter überwacht und der Sauerstoffgehalt nach Bedarf entsprechend dieser Überwachung durch zwangsläufiges Einleiten von Umgebungsluft in den Behälter automatisch auf einen optimalen oder vorbestimmten Wert oder Wertebereich reguliert wird, und (ii) Überwachen des Kohlendioxidgehalts in dem Behälter und Regulieren des Kohlendioxidgehalts nach Bedarf entsprechend dieser Überwachung auf einen optimalen oder vorbestimmten Wert oder Wertebereich, ohne daß zu diesem Zweck mit einem sauerstoffarmen oder sauerstofffreien Gas gespült wird, wobei die Regulierung zunächst durch Waschen der in dem Behälter befindlichen Luft erfolgt, wenn der Kohlendioxidgehalt über einen ersten vorbestimmten Wert ansteigt, und zweitens, wenn der Kohlendioxidgehalt über einen zweiten höheren vorbestimmten Wert ansteigt, durch zwangsläufiges Einleiten von Umgebungsluft in den Behälter.

2. Verfahren nach Anspruch 1, bei dem der Behälter gekühlt wird und eine automatische Temperaturregelung erfolgt.

3. Verfahren zum Transport einer Menge atmender Lebensmittel, die sich durch Atmung zersetzen können, wobei die Vorrichtung folgendes umfaßt:
eine transportable Einrichtung, die ein Volumen einer gasförmigen Umgebung für die Lebensmittel aufweist, das im wesentlichen dicht verschlossen werden kann, und in dem die zu transportierenden Lebensmittel getragen werden können;
eine Einrichtung, mit der das Volumen bzw. der Hohlraum nach dem Beschicken mit den Lebensmitteln dicht oder im wesentlichen dicht verschlossen wird, so daß weniger Sauerstoff aus der Umgebungsluft

in den Hohlraum eindringen kann als für die Atmung erforderlich ist;
eine Einrichtung, mit der der Hohlraum mit einem sauerstofffreien oder sauerstoffarmen Gas gespült werden kann, um seinen Sauerstoffgehalt unter den der Umgebungsluft abzusenken;
eine Einrichtung zur Überwachung des Sauerstoffgehalts in dem Hohlraum;
eine Einrichtung zur Überwachung des Kohlendioxidgehalts in dem Hohlraum;
eine Einrichtung, die in Abhängigkeit von der Einrichtung zur Überwachung des Sauerstoffgehalts eine zwangsläufige Einleitung von Umgebungsluft in den Hohlraum veranlaßt, wenn der Sauerstoffgehalt einen vorbestimmten Wert besitzt oder unter diesen abfällt;
eine Einrichtung, die in Abhängigkeit von der Einrichtung zur Überwachung des Kohlendioxidgehalts Gas in dem Hohlraum durch die Einrichtung strömen läßt, um wenigstens etwas von dem Kohlendioxid herauszuwaschen, wenn der Kohlendioxidgehalt über einen ersten vorbestimmten Wert ansteigt; und
eine Einrichtung, die in Abhängigkeit von der Einrichtung zur Überwachung des Kohlendioxidgehalts eine zwangsläufige Einleitung von Umgebungsluft in den Hohlraum veranlaßt, wenn der Kohlendioxidgehalt von der Einrichtung, die wenigstens etwas von dem Kohlendioxid aus dem Hohlraum herauswäscht, nicht unter einem höheren zweiten vorbestimmten Wert gehalten wird.

4. Vorrichtung nach Anspruch 3, bei der der Hohlraum sich in einem Behälter befindet, der einen Lagerraum für atmende Lebensmittel aufweist.

5. Vorrichtung nach Anspruch 3, bei der eine Einrichtung zur Überwachung der Temperatur in dem Hohlraum vorgesehen ist und außerdem eine Einrichtung, die in Abhängigkeit von der Einrichtung zur Überwachung der Temperatur in dem Hohlraum die Temperatur in dem Hohlraum wenigstens nach unten auf einen vorbestimmten Wert reguliert.

6. Gasregler für einen Behälter, wobei "Behälter" definiert ist als jede Einrichtung, die eine Lagerraum für atmende Lebensmittel aufweist, umfassend eine Einrichtung zum Extrahieren von CO_2 aus der Behälterluft und eine Einrichtung zum Austausch von Umgebungsluft mit Behälterluft, wobei der Regler folgendes umfaßt:
einen Mikroprozessor, einen Nur-Lese-Speicher und einen Schreib-Lese-Speicher, die mit einem gemeinsamen Datenübertragungsbus verbunden sind;
eine Kohlendioxiddetektor zur Überwachung des Kohlendioxidgehalts in der Behälterluft;
einen Sauerstoffdetektor zur Überwachung des Sauerstoffgehalts in der Behälterluft;
eine Einrichtung, die den Ausgang der Detektoren mit dem Bus verbindet; und
einen Ausgabebaustein, der mit dem Bus verbunden ist, um von dem Mikroprozessor Steuersignale abzusetzen, die die Extraktionseinrichtung und die Austauscheinrichtung aktivieren bzw. deaktivieren;
wobei der Mikroprozessor ein Programm ausführt, das in dem Nur-Lese-Speicher gespeichert ist, wobei das Programm
a) den Kohlendioxidgehalt und den Sauerstoffgehalt überwacht;
b) die Extraktionseinrichtung aktiviert bzw. deaktiviert, wenn der Kohlendioxidgehalt einen vorbestimmten Wert oder Wertebereich übersteigt oder unter diesen abfällt;
c) die Austauscheinrichtung aktiviert bzw. deaktiviert, wenn der Kohlendioxidgehalt einen vorbestimmten Höchstwert oder Grenzwertbereich für den Kohlendioxidgehalt übersteigt oder unter diesen abfällt, der höher ist als der genannte Wert oder Wertebereich; und
d) die Austauscheinrichtung aktiviert bzw. deaktiviert, wenn der Sauerstoffgehalt unter einen vorbestimmten Wert oder Wertebereich absinkt oder diesen übersteigt.

7. Gasregler nach Anspruch 6, bei dem das Aktivieren/Deaktivieren das Öffnen/Schließen von Magnetventilen umfaßt.

8. Gasregler nach Anspruch 6 oder Anspruch 7, bei dem die vorbestimmten Werte bevorzugte Werte für den Transport atmender Lebensmittel in dem Behälter sind.

9. Gasregler nach einem der Ansprüche 6 bis 8, bei dem der vorbestimmte Kohlendioxidgrenzwert ein Grenzwert ist, über dem die in dem Behälter transportierten Lebensmittel in inakzeptabler Weise beschädigt werden.

10. Gasregler nach einem der Ansprüche 6 bis 9, bei dem die Einrichtung zum Verbinden des Ausgangs der Detektoren mit dem Bus einen Analogmultiplexer umfaßt, der mit einem A/D-Wandler in Reihe

geschaltet ist.

11. Gasregler nach einem der Ansprüche 6 bis 10, bei dem das Programm in vorbestimmten Abständen den Kohlendioxid- und Sauerstoffgehalt in ein herausnehmbares Speicherelement schreibt, das über den Bus mit dem Mikroprozessor verbunden ist.

Revendications

1. Procédé de transport d'une quantité d'un produit comestible pouvant être sujet à altération en résultat d'une respiration durant le transport, comportant les étapes consistant à:
   (a) enfermer hermétiquement ou sensiblement hermétiquement ladite quantité du produit comestible respirant à l'intérieur d'un récipient, ledit "récipient" étant défini comme étant un moyen quelconque délimitant une chambre de stockage pour des produits comestibles respirants, suffisamment pour assurer que moins d 'oxygène de l'air ambiant que la quantité nécessaire pour une respiration complète du produit comestible respirant puisse diffuser dans le récipient, balayer le récipient avec un gaz pauvre en oxygène ou sans oxygène de manière à assurer un taux d'oxygène réduit dans le récipient hermétique ou sensiblement hermétique, un tel balayage se produisant avant, durant et/ou après ledit enfermement hermétique ou sensiblement hermétique, et
   (b) transporter le récipient contenant le produit comestible respirant tout en (i) contrôlant le taux d'oxygène à l'intérieur dudit récipient et en réglant automatiquement le taux d'oxygène nécessaire par une injection positive d'air ambiant dans le récipient en réponse à ce contrôle vers une valeur ou fourchette de valeurs optimal ou prédéterminée et (ii) en contrôlant le taux de gaz carbonique à l'intérieur dudit récipient et en réglant le taux de gaz carbonique nécessaire en réponse à ce contrôle vers une valeur ou une fourchette de valeurs optimal ou prédéterminée indépendamment du balayage par un gaz pauvre en oxygène ou sans oxygène, ledit réglage étant tout d'abord effectué par épuration de l'air à l'intérieur dudit récipient au cas où ledit taux de gaz carbonique s'élève au-dessus d'une première valeur prédéterminée, et,en second lieu, au cas où ledit taux de gaz carbonique s'élève au-dessus d'une seconde valeur prédéterminée supérieure, par l'injection positive d'air ambiant dans le récipient.

2. Procédé selon la revendication 1, dans lequel ledit récipient est réfrigéré et possède un réglage automatique de la température.

3. Dispositif de transport d'une quantité de produits comestibles respirants pouvant être altérés par respiration, ledit dispositif comportant:
   des moyens transportables délimitant un volume d'environnement gazeux pour lesdits produits comestibles pouvant être fermé pratiquement hermétiquement,et dans lesquels les produits comestibles devant être transportés peuvent être contenus;
   des moyens pour fermer hermétiquement ou sensiblement hermétiquement ledit volume après chargement desdits produits comestibles de telle sorte que moins d'oxygène de l'air ambiant que la quantité nécessaire pour la respiration puisse diffuser dans l'environnement ;
   des moyens permettant un balayage de l'environnement avec un gaz pauvre en oxygène ou sans oxygène pour réduire la teneur en oxygène de celui-ci au-dessous de celle de l'air ambiant;
   des moyens pour contrôler la teneur en oxygène de l'environnement;
   des moyens pour contrôler la teneur en gaz carbonique de l'environnement;
   des moyens sensibles aux moyens pour contrôler la teneur en oxygène pour provoquer une injection positive d'air ambiant dans l'environnement au cas où la teneur en oxygène est ou tombe au-dessous d'une valeur prédéterminée;
   des moyens sensibles aux moyens pour contrôler ladite teneur en gaz carbonique pour provoquer un passage de gaz à l'intérieur de l'environnement à travers des moyens d'épuration d'au moins une partie du gaz carbonique de ceux-ci au cas où ladite teneur en gaz carbonique s'élève au-dessus d'une première valeur prédéterminée; et
   des moyens sensibles aux moyens pour contrôler ladite teneur en gaz carbonique pour provoquer une injection positive d'air ambiant dans l'environnement au cas où ladite teneur en gaz carbonique n'est pas maintenue au-dessous d'une seconde valeur prédéterminée supérieure par lesdits moyens d'épuration d'au moins une partie du gaz carbonique de l'environnement.

4. Dispositif selon la revendication 3, dans lequel ledit environnement se trouve à l'intérieur d'un récipient délimitant une chambre de stockage pour des produits comestibles respirants.

5. Dispositif selon la revendication 3, dans lequel sont prévus des moyens pour contrôler la température de l'environnement et de plus des moyens sensibles aux moyens contrôlant la température de l'environnement pour régler au moins à la baisse la température de l'environnement vers une valeur prédéterminée.

6. Contrôleur de gaz pour un récipient, dans lequel ledit "récipient" est défini comme étant un moyen quelconque délimitant une chambre de stockage pour des produits comestibles respirants, possédant des moyens pour une extraction de CO_2 de l'air du récipient et des moyens d'échange d'air ambiant avec l'air du récipient, ledit contrôleur comportant:

un microprocesseur, une mémoire morte et une mémoire de lecture-écriture connectés à un bus de communication commun;

un détecteur de gaz carbonique pour contrôler le taux de gaz carbonique dans l'air du récipient;

un détecteur d'oxygène pour contrôler le taux d'oxygène dans l'air du récipient;

des moyens pour relier la sortie desdits détecteurs audit bus; et

un point de connexion de sortie relié audit bus pour une délivrance depuis ledit microprocesseur de signaux de commande qui activent/désactivent lesdits moyens d'extraction et lesdits moyens d'échange:

dans lequel ledit microprocesseur exécute un programme mémorisé dans ladite mémoire morte, lequel programme:

(a) contrôle ledit taux de gaz carbonique et d'oxygène;

(b) active/désactive lesdits moyens d'extraction si ledit taux de gaz carbonique s'élève au-dessus de/s'abaisse au-dessous d'une limite ou fourchette de limites de gaz carbonique prédéterminées;

c) active/désactive lesdits moyens d'échange si ledit taux de gaz carbonique s'élève au-dessus de / s'abaisse au-dessous d'une limite ou fourchette de limites supérieure de gaz carbonique prédéterminées dépassant ladite limite ou fourchette de limites de gaz carbonique.

d) active/désactive lesdits moyens d'échange si ledit taux d'oxygène tombe au-dessous/s'élève au-dessus d'un taux ou d'une fourchette de taux d'oxygène prédéterminés.

7. Contrôleur de gaz selon la revendication 6, dans lequel ladite activation/désactivation comporte l'ouverture/fermeture d'électro-vannes.

8. Contrôleur de gaz selon la revendication 6 ou la revendication 7, dans lequel lesdits taux prédéterminés sont des taux préférés pour un transport de produits comestibles respirants à l'intérieur dudit récipient.

9. Contrôleur de gaz selon l'une quelconque des revendications 6 à 8, dans lequel ladite limite prédéterminée de gaz carbonique est une limite au-dessus de laquelle une détérioration inadmissible est provoquée pour des produits comestibles transportés dans ledit récipient.

10. Contrôleur de gaz selon l'une quelconque des revendications 6 à 9, dans lequel lesdits moyens reliant la sortie desdits détecteurs audit bus comportent un multiplexeur analogique en série avec un convertisseur analogique-numérique.

11. Contrôleur de gaz selon l'une quelconque des revendications 6 à 10, dans lequel ledit programme enregistre à des intervalles prédéterminés lesdits taux de gaz carbonique et d'oxygène dans un élément de mémoire amovible connecté audit microprocesseur par l'intermédiaire dudit bus

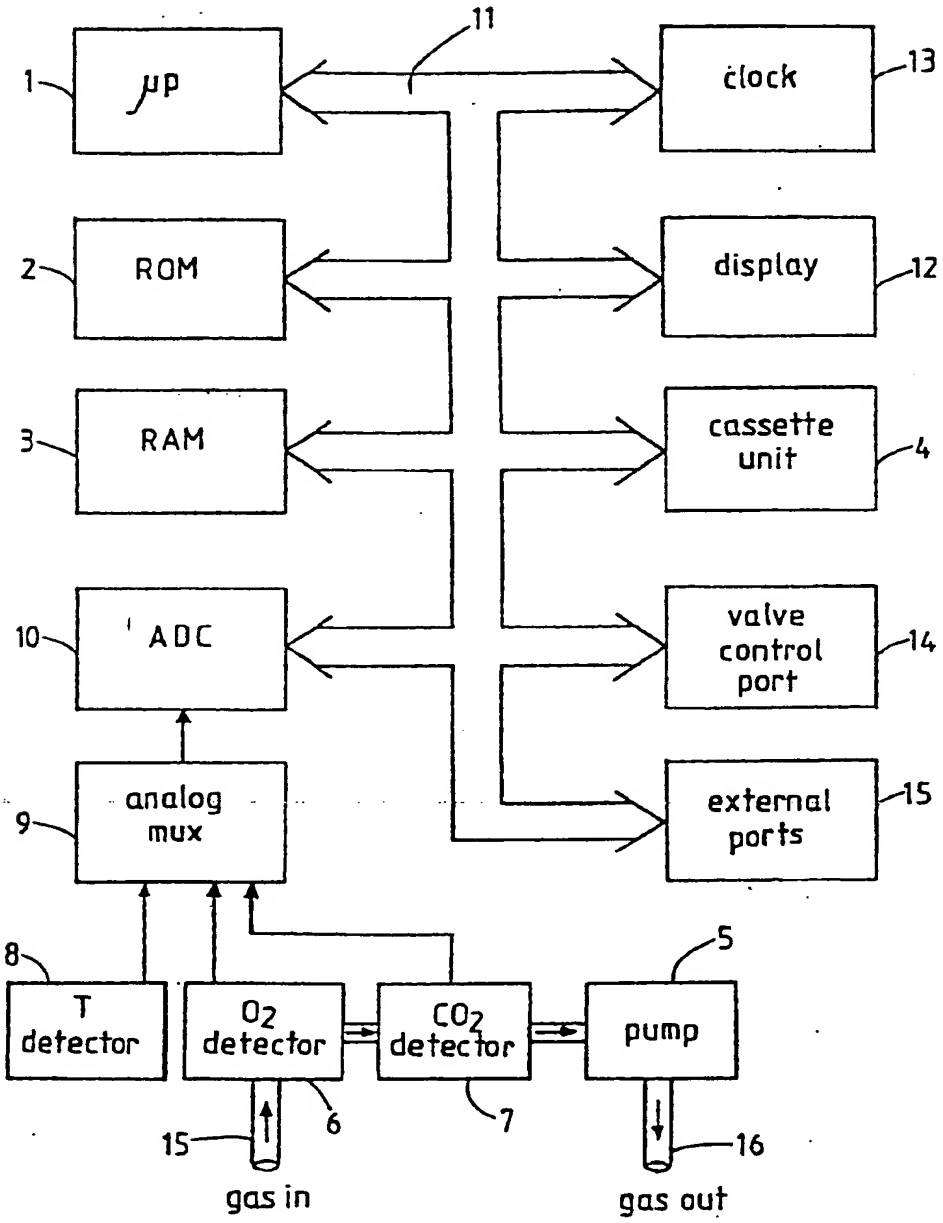
11
1
µp
clock
13
2
ROM
display
12
3
RAM
cassette unit
4
10
ADC
valve control port
14
9
analog mux
external ports
15
8
5
T detector
O2 detector
CO2 detector
pump
15
6
7
16
gas in
gas out

FIG.1

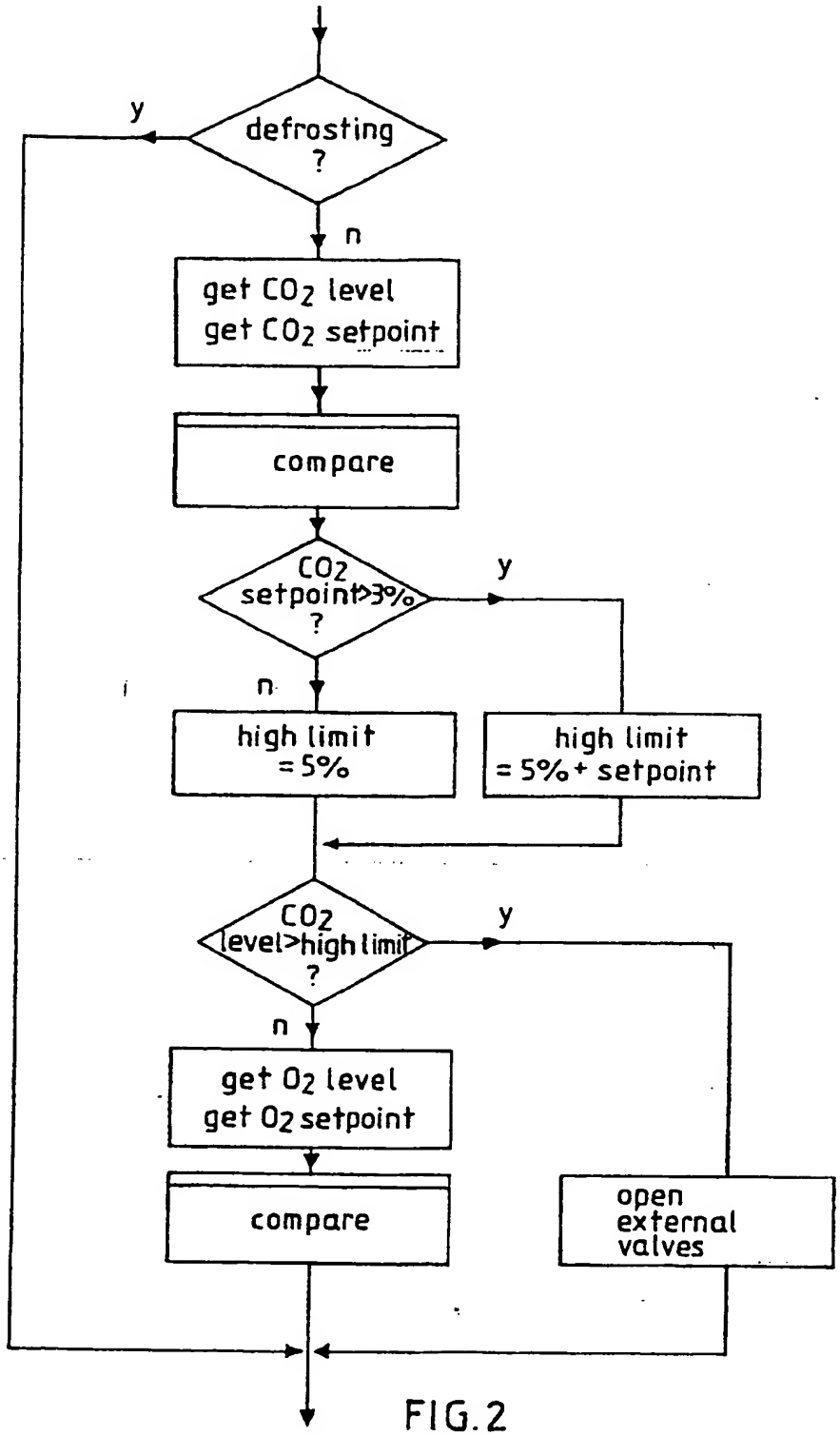
defrosting ?
y
n
get CO_2 level
get CO_2 setpoint
compare
CO_2 setpoint>3% ?
y
n
high limit = 5%
high limit = 5% + setpoint
CO_2 level>high limit ?
y
n
get O_2 level
get O_2 setpoint
compare
open external valves

FIG.2

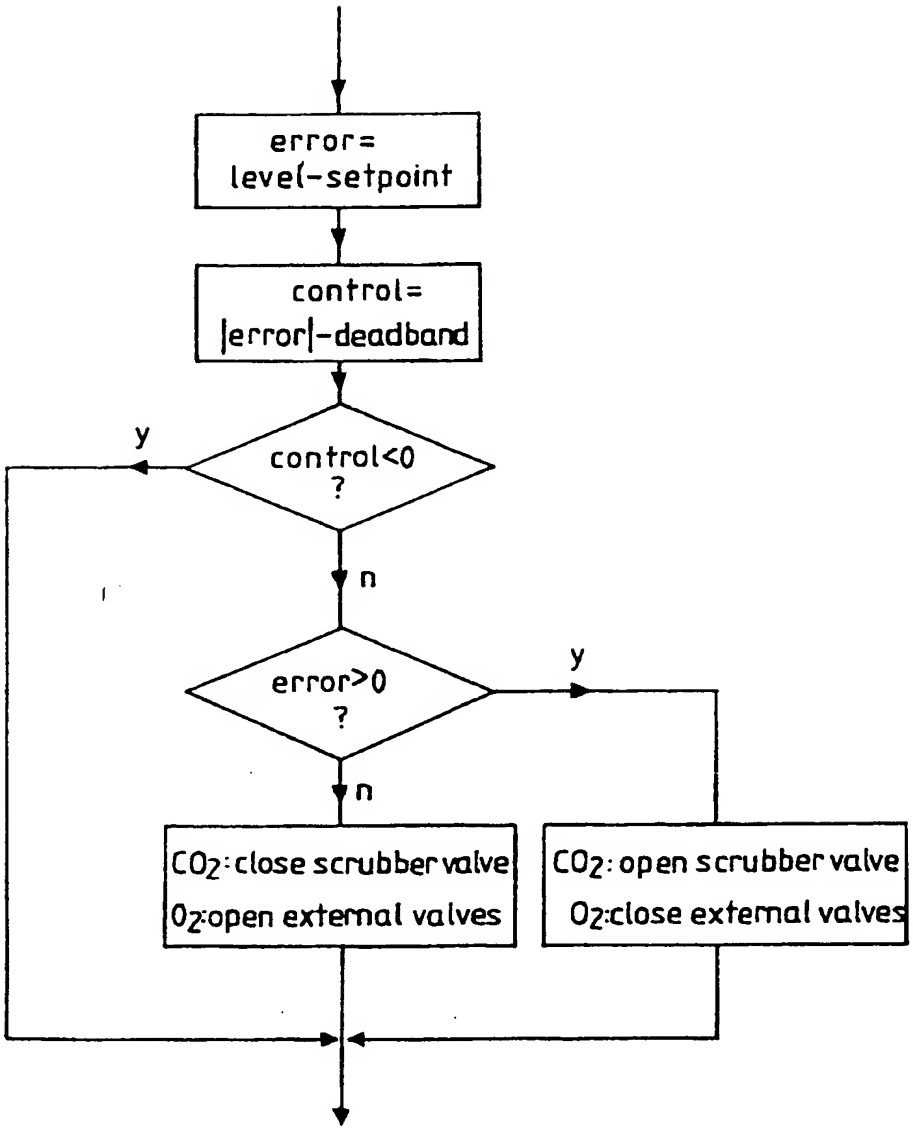
error=
level-setpoint
control=
|error|-deadband
control<0
?
y
n
error>0
?
y
n
CO_2: close scrubber valve
O_2: open external valves
CO_2: open scrubber valve
O_2: close external valves

FIG. 3